

# ultra low power wirelessQ

QUARTER 3 | AUTUMN 2016

## COVER STORY

# Tech toys strike back



The promise of low power cellular IoT  
Preparing for Bluetooth 5.0  
Runners adopt power monitoring

# OPINION

Svenn-Tore Larsen



## Low power cellular IoT: one giant step forward for Nordic

In the last edition of this magazine ([ULP WQ Summer 2016](#)) we looked back at Nordic Semiconductor's achievements over the previous decade. In one of the articles ("Building a billion-dollar IoT company: Bluetooth low energy is just the beginning" - see [ULP WQ Summer 2016 Special Supplement pg 11](#)), I spoke of how advancing the company from a niche semiconductor vendor of 2.4 GHz proprietary technology to one of the major players in Bluetooth low energy technology took leadership, boundless energy, millions of dollars in investment, and a lot of hard work from talented hardware and software engineering teams.

It's fitting, then, that in this edition we are announcing the next stage of the company's growth strategy. To be successful, this strategy will take all of the company attributes that have propelled Nordic this far ... and then some. It's a strategy built on our ambition to target high growth markets; and those markets don't come much bigger than the Internet of Things (IoT).

Nordic is no stranger to the IoT; our nRF51 and nRF52 Series Bluetooth low energy Systems-on-Chip (SoCs) power millions of sensors already connected to this network. But, as impressive as it is, Bluetooth low energy wireless can only take the IoT so far. The technology is, by design, short range, so Bluetooth low energy will need to be complemented by longer-range wireless technologies if the IoT is to reach full potential.

Like the 3rd Generation Partnership Project (3GPP - a collaboration between major telecoms partners tasked with developing cellular standards), Nordic believes the most pragmatic approach is to base these technologies on Long Term Evolution (LTE) cellular networks. These networks are rapidly being constructed and are built using proven technology based on internationally-accepted standards.

According to telecoms company Ericsson, around 400 million Machine-to-Machine (M2M) and consumer electronics devices (such as smart TVs, set-top boxes, and games consoles) were connected to the cellular network by the end of 2015. That number is expected to expand to 1.5 billion by 2021. Many of those new connections will be driven by demand to link things such as logistics services, 'connected cars', machines, and smart utility meters to the IoT. To achieve these numbers, we'll need new, low-power, low-cost, long-range forms of LTE. That's why Nordic's roadmap includes a family of low power cellular IoT chipsets—the nRF91 Series—that will adhere to the latest LTE specifications from the 3GPP. (See [this issue pg 8](#).)

The announcement of the nRF91 Series comes almost two years to the day since we identified a happy coincidence - the emergence of low power cellular technology and the availability of a pool of talented and experienced LTE engineers released from major telecoms- and wireless chip-vendors. The combination of a decade of ultra-low power wireless experience and that [world-leading LTE expertise](#) puts Nordic in a strong position to be an innovator in low power cellular IoT development. Further, the growth of cellular IoT will accelerate adoption of the IoT which in turn will dramatically increase demand for the company's Bluetooth low energy SoCs.

Yours Sincerely,

**Svenn-Tore Larsen**  
CEO

## Contributors



Page 9

**Thomas Embla Bonnerud** is Director of Strategy with Nordic Semiconductor. Here he looks at low power cellular technology and how it's driving IoT development



Page 10

**Pär Håkansson** is Product Marketing Manager at Nordic Semiconductor. On page 10 he looks at how Android's new OS has beefed up Touch-to-Pair security



Page 18

**Kat Kent** is a Canada-based technology journalist and a wireless applications engineer. On page 18 she examines the sensor technology improving runners' workouts



Wireless connectivity is driving a resurgence in the toy industry

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# NEWS

The latest developments from Nordic Semiconductor

## S132 SoftDevice boosts Bluetooth data throughput

Nordic Semiconductor has introduced its production-ready [S132 SoftDevice](#) version 3.0. The SoftDevice increases Bluetooth low energy data throughput rates up to 500 percent by employing the enhanced 'Long Attribute (ATT) Maximum Transfer Unit (MTU)' and 'Data packet length extension (DLE)' features of Bluetooth 4.2.

The enhancement delivers a number of benefits in applications ranging from multi-function wearables to smart home solutions. These enhancements include significantly faster over-the-air firmware updates, lower power consumption in data-intensive applications, and more responsive user-experiences.

In addition to Bluetooth 4.2's increased data throughput capability, the new SoftDevice



The S132 SoftDevice version 3.0 is designed for wearables and smart home applications

brings additional security to product developers with 'Link Layer (LL) Privacy'. This prevents tracking of private advertising Bluetooth low energy products when connecting to trusted devices. Idle connections, where data is not transmitted for long periods of time, have also been made more secure with a feature called 'Link Layer (LL) Ping', which periodically performs

secure authentication of connected devices.

Long ATT MTU and DLE increase the maximum Bluetooth low energy throughput by increasing the size of the MTU read and write values from 23 bytes up to 512 bytes, and by increasing on-air data packet length from 27 bytes up to 251 bytes. The result of combining these enhancements is a data throughput above 800 kbps.

"Because it's designed to run on the Nordic's nRF52832 Bluetooth low energy single-chip SoC, Nordic customers employing the S132 SoftDevice will benefit from a maximum data throughput that far exceeds that achievable by existing Bluetooth low energy SoCs on the market today," says John Leonard, Product Marketing Manager at Nordic.

## In brief

### nRF52832 WL-CSP variant unveiled

Nordic Semiconductor has released a Wafer Level Chip Scale Package (WL-CSP) variant of its nRF52832 Bluetooth low energy System-on-Chip (SoC). The chip occupies a quarter of the area of the standard-packaged Nordic nRF52832, and targets wearables and space-constrained IoT applications. The nRF52832 WL-CSP has a super-compact 3.0 by 3.2mm footprint compared to the standard 6.0 by 6.0mm footprint of Nordic's QFN48-packaged nRF52832.

### ANT SoC modules and starter kit

Dynastream Innovations has released its new D52Q modules, the first modules in the [D52 ANT SoC Module](#) Series with ANT and Bluetooth low energy concurrent support. D52Q modules employ Nordic's nRF52832 SoC, and are available in two variants: one with up to 30GPIOs and another with up to 24GPIOs and an on-board 3-axis accelerometer. The D52 ANT SoC Module starter kit is said to provide everything developers need to begin designing with D52 series modules and ANT.

### Nordic countries leading on IoT

A report from the United Nations' specialized agency for information and communication technologies claims Nordic countries are global leaders when looking at machine-to-machine subscriptions relative to the number of mobile cellular subscriptions. The ITU report found there are already more connected things than people in the Nordics, and by 2017 the number of connected things per person will rise to 2.6. Sweden, Norway, and Finland all ranked in the top four.

## Smart sports bra delivers heart rate data

A new smart sports bra employs Nordic Semiconductor's [nRF51422](#) multiprotocol System-on-Chip (SoC). The chip provides Bluetooth low energy and legacy wireless connectivity enabling heart rate tracking to female athletes on virtually any fitness monitoring device.

Mi Pulse, a Boulder, Colorado-based smart clothing company has launched the Mi Pulse Smart Bra, an integrated sports bra and heart rate strap that offers ANT+ and Bluetooth low energy wireless connectivity, as well as support for legacy 5.3 kHz analog connectivity found in the majority of gym equipment.

The Smart Bra integrates a 'tri-mode' heart rate monitor (HRM) into the bra itself that can be removed and freely swapped between bras. The Smart Bra works with all leading app vendors including Garmin, Suunto, Strava, MapMyFitness, Runtastic, Wahoo Fitness, Google Fit, and Apple Health, as well as a range of other apps that support heart rate information.

The Mi Pulse Smart Bra is powered by a CR2032 coin cell battery. Battery life is dependent on the frequency of exercise, and the



The Smart Bra integrates a 'tri-mode' heart rate monitor into the bra itself

number of devices the HRM is connected to at one time, but in normal operation the cell provides power for more than nine months.

"Our demographic wants our product to 'just work' and they shouldn't be concerned with the complexity of RF protocols or need to revert to owner's manuals," says Mi Pulse Co-Founder, Hilary Taylor. "Wireless is all about ease of use and mobility. For example, there's no need to worry about charging batteries as our HRM works for months from a single cell."

## In brief

### Bonnerud appointed Director of Strategy

**Thomas Embla Bonnerud has been appointed Director of Strategy and Investor Relations at Nordic Semiconductor. Bonnerud will be responsible for setting the strategic direction for the company as it develops its Bluetooth low energy and forthcoming low power cellular IoT product families, as well as being Nordic's point of contact with investors and the financial markets. Bonnerud has been with Nordic in a range of positions since 2001, and is currently responsible for the company's overall product roadmap. He will report direct to CEO Sverre Tore Larsen.**

### NFC added to proximity beacons

Bluetooth low energy beacon manufacturer [Estimote](#) has added programmable NFC into its new range of proximity beacons. The change will make it easier to identify and configure the devices and to enable a range of consumer experiences such as confirming payment, collecting loyalty points, and clocking-in. Users can set up NDEF records of up to 256 bytes total through the secure configuration API. Estimote says it has tripled the default responsiveness and battery life is still over two years.

### Bluetooth 5.0 drives IoT deployments

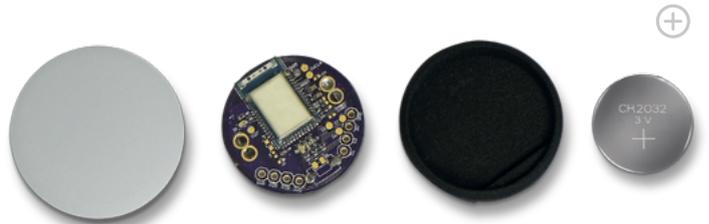
With the technical enhancements enabled by Bluetooth 5.0, in addition to the support of mesh networking, and Internet protocol, ABI Research forecasts Bluetooth-enabled device shipments will increase by an average of half a billion per year through 2021, reaching more than five billion. Bluetooth will extend beyond cable replacements and smartphones into the wider IoT landscape and result in the development of larger scale networks that no longer rely on the smartphone as a hub, the research claims.

## Open source beacon offers simple programming and debugging

Espruino has launched an open source Bluetooth low energy beacon, Puck.js, said to be so simple to program and debug that almost anyone can do it wirelessly from a website using a graphical editor or JavaScript.

The Puck.js has all the required programming and debug software tools built-in, and runs from a Nordic [nRF52832](#) Bluetooth low energy System-on-Chip (SoC) with built-in ARM Cortex M4F processor.

"Most manufacturers conveniently gloss over the difficulties of programming their hardware, and other beacons are provided without software or left crippled by their boring factory-installed firmware," says UK-based creator, Gordon Williams. "Puck.js is different. It comes with our Open Source JavaScript interpreter 'Espruino' pre-installed, which makes it incredibly easy-to-use and means



The Puck.js is easily programmable for home automation and IoT projects

you can get started in just seconds, without any prior programming experience."

The intentionally hacker-friendly Puck.js supports both the iBeacon and Eddystone beacon formats, and will be supplied with firmware updates for the forthcoming Bluetooth 5.0 specification. Powered from a CR2032 coin cell battery, the beacon has a circular 35 by 10-mm form factor, and includes a magnetometer, a user-assignable button, and four (red, green, blue, and infrared) LEDs.

The Puck.js can measure

rotation, light, temperature, magnetic fields, can control infrared devices, and produce color light, acting as a Bluetooth low energy beacon out-of-the-box, or customizable for home automation, IoT prototyping, and education purposes.

"The aim of Puck.js is to lower the barrier-to-entry and make development easier and more fun – allowing access to Bluetooth low energy beacon and IoT technologies that may otherwise be restricted to professional embedded developers," says Williams.

## Health wearable offers stressed users wellness coaching and feedback

UK-based technology design company, Vinaya, has launched a new health and wellness wearable, 'ZENTA', that employs Nordic's [nRF52832](#) System-on-Chip (SoC) to support the intensive computational requirements of the Bluetooth low energy application, while meeting low power consumption requirements.

ZENTA is a wrist-worn device that tracks the user's physical activity, sleep quality, breathing patterns, stress levels, emotional states, and mood. The device not only provides the user's data via the app dashboard but also offers actionable insights, suggestions, and a methodology for self-improvement against an individual's personally set goals.

ZENTA employs a range of sensors to capture a wealth of data about the user and their surrounds. The device is equipped with an accelerometer, a microphone, biometric sensors, and a haptic engine that gather environmental noise, movement, as well as biological signals from the user including heart rate, heart rate variability, breathing patterns, electrodermal activity (EDA), skin temperature, pulse transit time, pulse

wave velocity, and blood oxygen saturation.

The sensor data is automatically synced to a smartphone after which each one of these data points is cross-referenced with other data points from the user's smartphone, for example location, calendar events, or digital activity to log 'bio-events' that provide insight into significant deviations in the user's baseline or habitual behavior.

Vinaya required high performance from the Nordic SoC to act as ZENTA's main controller for filtering and conditioning. The SoC also provides the first level of data manipulation, yet still supports up to five days of continuous biometric sensing and Bluetooth low energy wireless connectivity between recharges.

ZENTA tracks activity, sleep quality, and even the user's mood



# Smart remote control reference design features state-of-art voice input functions

Nordic Semiconductor has launched its 'nRFready [Smart Remote 3](#) for nRF52 Series' reference design, delivering remote control OEMs/ODMs and manufacturers of smart TVs, set-top boxes, and digital media devices with a complete hardware and software Bluetooth low energy solution.

The reference design is designed to deliver a rich, intuitive, and engaging end-user experience and features state-of-the-art voice input for speech recognition-driven search and control functions using a pair of PDM microphones for echo and noise cancellation.

The reference design also features a digital microphone

input option, six-axis motion sensor 'air-mouse' for physical gesture control, multi-touch trackpad, a matrix of programmable keyboard buttons, legacy IR support, NFC Touch-to-Pair (future software release), and an on-board buzzer for the Bluetooth low energy 'Find Me' Profile.

"With the extra processing performance of the nRF52832 and on-chip PDM support we have been able to extend the audio functionality of our existing '[nRFready Smart Remote 3](#) for nRF51 Series' reference design. The product now includes two digital microphones and all required signal processing in a single chip implementation for



**The reference design delivers a rich and engaging end-user experience**

state-of-the-art voice input search and control of home media devices," comments John

Leonard, Product Marketing Manager at Nordic.

"The computing power of the nRF52832 combined with its unique set of peripherals has allowed us to optimize every major function of the remote control reference design, and do some really effective audio noise cancellation and associated audio compression on voice data."

nRFready Smart Remote 3 for nRF52 Series supports a range of popular audio compression formats including Opus, Broadvoice, and ADPCM. It comes complete with all the embedded software to complete a voice remote control design, including host-side support software for Linux boxes.

## Beacon development platform targets maker community

Finnish start-up Ruuvi Innovations has launched a Nordic Semiconductor-powered beacon, providing an open-source development platform for developers, makers, and hobbyists.

RuuviTag employs Nordic's [nRF52832](#) Bluetooth low energy System-on-chip (SoC), and can act as both a standard proximity beacon as well as offering temperature, humidity, air pressure, and acceleration sensors in an open-source platform that conforms to Apple iBeacon and Google Eddystone specifications. The device has a transmission range up to 100 m, and can also be used to create mesh networks using the Wirepas Connectivity protocol. The ultra low power operating characteristics of Nordic's nRF52832 SoC extend RuuviTag's CR2450 or CR2477 Li-ion coin cell battery life up to 10 years.

Example applications for the RuuviTag



RuuviTag's hardware can be used as the foundation stone for commercial products

include deployment as a remote weather station broadcasting environmental and atmospheric data to an app on a smartphone,

or attachment to an object to notify the owner if it is moved. Because RuuviTag is an open-hardware and -software platform, developers and makers are free to design and share their own applications. Ruuvi Innovations also offers a range of over-the-air upgradable example application software based on Nordic's nRF52 Software Development Kit (SDK).

The RuuviTag platform's hardware can be used as the foundation for commercial products. The hardware can even be customized to meet specific customer requirements.

"There are many traditional beacon providers out there but the market needs more open-source IoT [Internet of Things] sensor solutions, that's why we have released all our hardware design and software code to the public," says Lauri Jämsä, CEO of Ruuvi Innovations.

## ANT profile for location tracking

ANT Wireless has released a new [ANT+ Device Profile](#) for location-tracking devices named 'Tracker' that is designed for IoT developers looking to enhance location tracking by passing information from an assets tracker to a secondary display like a watch or GPS screen. Potential applications include GPS dog tracking, as well as other tracking technologies such as livestock monitoring systems, or asset tracking devices. ANT says profiles like Tracker allow for greater flexibility in where and how sensor data can be viewed and aggregated.

## Wireless remote battery monitoring

Victron Energy has launched a new Bluetooth low energy-based battery charger that provides wireless remote configuration and monitoring of batteries during charging. Powered by Nordic Semiconductor's nRF51822 System-on-Chip (SoC), the Blue low energy IP65 battery charger range enables users to charge 12 and 24 V batteries, and monitor voltage and amp readouts from the VictronConnect app on their smartphone, tablet, or PC. The battery chargers are designed for automotive, marine, and industrial applications.

In brief

# Nordic gains access to novel NFC payment solutions through Asian deal

Nordic Semiconductor has expanded its Asian distributor network, signing an agreement with Fuchance Enterprise Co. Ltd (Opto-Sensor Ltd) for representation in Taiwan.

Fuchance Enterprise specializes in secure, Near Field Communication (NFC)-based mobile and wearable payment solutions, as well as sales of optical sensors, infrared receiver modules, and RFID/NFC. Central to the agreement is Fuchance Enterprise's software solution that takes advantage of the Nordic's nRF52832 Bluetooth low energy System-on-Chip's (SoC) [built-in NFC-A tag](#) to enable secure NFC payments from the Nordic SoC. The SoC provides a compact, single-chip solution for developers wishing to offer secure payment functionality in addition to Bluetooth low energy connectivity from, for instance, a wearable device.

The agreement also covers sales, marketing, and support for Nordic Semiconductor's full range of ultra low power 2.4GHz



Deal done: Fuchance Enterprise's Joe Wang (left) and Nordic's Ståle "Steel" Ytterdal

wireless solutions in Taiwan, including Nordic's proven nRF51 Series SoCs, as well as the

nRF52832.

Commenting on the agreement, Joe Wang, Director

of Sales and Marketing at Fuchance Enterprise says: "Having the opportunity to represent Nordic not only completes our solution portfolio but also gives us a competitive advantage to offer industry leading Bluetooth low energy technology, particularly for payment solutions.

"We are receiving solid demand and positive feedback from customers with end products such as wearable payment devices, payment terminals, health care devices, as well as smart home devices," adds Wang.

"APAC is driving the adoption of secure, wireless payment solutions, and Fuchance Enterprise is a specialist and has a lot of experience in this area," adds Ståle "Steel" Ytterdal, Nordic's Director of Sales & Marketing - APAC. "This track record will benefit both new and existing Nordic customers who have a particular interest in adding secure NFC payment technology to their wearable products without compromising on compact size."

## Modules simplify EIoT RF development and certification

U.K. embedded connectivity solutions ODM, Laird, has developed its second-generation of Nordic Semiconductor-based Bluetooth low energy certified modules.

The modules provide a comprehensive certified solution that leverages the latest technology to enhance security, power consumption, and future-proofing of Bluetooth low energy wireless applications.

Employing the Nordic nRF52832 System-on-Chip (SoC), the [Laird BL652 module](#) targets industrial and medical applications, and is also

designed to simplify the RF development and certification work required to develop a Bluetooth low energy Enterprise Internet of Things (EIoT) application.

In addition to offering the flexibility of the Nordic nRF52 Software Development Kit (SDK), Laird also offers an object-based programming environment called 'smartBASIC'.

"smartBASIC was created to enable even those new to Bluetooth low energy—a common scenario in the emerging EIoT—to quickly and successfully develop real-world applications,"



The Laird module simplifies EIoT RF development work

comments Jonathan Kaye, Laird Connectivity Solutions Product Director.

"smartBASIC doesn't require a costly toolchain or complex development environment, only a terminal emulator of the user's choice."

To further accelerate developers' time-to-market, the BL652 is pre-approved to all necessary wireless certifications and qualifications including Bluetooth 4.2.

The module features an integrated antenna plus an option for external antenna, and is qualified over the full industrial -40 to +85°C operating temperature range.

In addition, the BL652 features NFC and robust security and encryption to provide a solution Laird says is capable of meeting the demands of industrial and enterprise applications alike.

# ULP WIRELESS TRENDS

*The latest developments in technology*



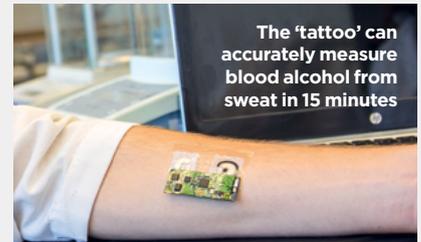
## Embedded 'wearable personal Cloud' powers up mobile computing

Researchers at the University of Alabama at Birmingham (UAB) in the U.S. are exploring the concept of a [wearable personal cloud](#) - a fully functioning, yet compact, and lightweight cloud computing system embedded into clothing. Using 10 Raspberry Pi's, an old winter jacket, three power banks, and a small remote touch screen display, Ragib Hasan, an Assistant Professor at UAB, and Rasib Khan, a recent postdoctoral student, developed a wearable that brings all mobile computing solutions together in a single smart device.

The "Cloud jacket" could make the design of wearable devices simple, inexpensive, and lightweight by allowing users to tap into the resources of the "wearable Cloud", instead of relying solely on the capabilities of their mobile hardware. The Cloud jacket prototype has roughly 10 GB of RAM, while each Raspberry Pi within the jacket has 32 GB of memory.

"Currently if you want to have a smartwatch, smartphone, an exercise tracker, and smart glasses, you have to buy individual expensive devices that [don't work together]," says Hasan. "Why not have a computational platform with you that can support many forms of wearable devices? Then all of these capabilities can become really inexpensive."

With a wearable Cloud, individual devices wouldn't need powerful processors because the wearable Cloud would provide the computing functionality currently performed by smart devices. By connecting the terminal devices via Bluetooth, the user would request services via a user intuitive display with computation performed by the wearable Cloud.



## Skin patch monitors alcohol levels

Engineers at the University of California San Diego have developed a flexible wearable sensor that can accurately measure a person's blood alcohol level from sweat in 15 minutes, and transmit the data wirelessly to a smartphone. The device could be used by doctors for non-invasive monitoring of blood alcohol.

The device consists of a temporary tattoo—which sticks to the skin, induces sweat and electrochemically detects the alcohol level—and a flexible circuit board, which is connected to the tattoo by a magnet and sends information to a mobile device via Bluetooth connectivity.

The tattoo is equipped with screen-printed electrodes and a small hydrogel patch containing pilocarpine, a drug that passes through the skin and induces sweat.

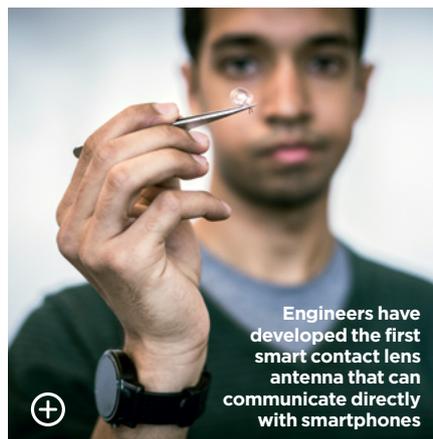
"This device can use a Bluetooth wireless connection, [unlike a Breathalyzer]," says Somayeh Imani, an electrical engineering PhD student in Mercier's lab. "We've found a way to make the electronics portable and wireless, which are important for practical, real-life use."

## Interscatter enables implanted devices to 'talk' using Bluetooth

University of Washington researchers have introduced a new way of communication that allows devices such as brain implants, contact lenses, credit cards, and smaller wearable electronics to talk to devices such as smartphones and watches.

"Wireless connectivity for implanted devices can transform how we manage chronic diseases," says co-author Vikram Iyer, an electrical engineering doctoral student at the university. "For example, a contact lens could monitor a diabetic's blood sugar level in tears and send notifications to a smartphone when the level goes down."

Due to their size and location within the body, these smart contact lenses are too constrained by power demands to send data



using conventional wireless transmissions. That means they so far have not been able to send data directly to smartphones and other mobile devices.

The team's process relies on a communication technique dubbed "interscattering", which allows devices to exchange information simply by reflecting existing wireless signals.

Interscatter communication uses the Bluetooth technology radios embedded in mobile devices to serve as both sources and receivers for reflected signals. The engineers developed a way to transform the Bluetooth wireless transmission into a 'single tone' signal that could be further manipulated and transformed.

# Nordic targets emerging low power cellular Internet of Things

The company's roadmap for long-range, low power cellular wireless products is part of a strategy to build market share in a wide number of high growth sectors

The Internet of Things (IoT) is typically described as a network of wired- and wirelessly-interconnected sensors attached to everything from fridges to cars, vending machines to traffic signals. These sensors send data to the Cloud where powerful computers can use the information to make decisions. It's an interesting vision of the future but one which typically glosses over exactly how the data will be moved across the network.

The good news is that companies such as Nordic Semiconductor are working hard to clear the engineering hurdles presented by such a challenge. By applying more than a decade of leadership in ultra low power (ULP) wireless technology, allied to its recruitment of a highly-experienced group of LTE (Long Term Evolution) and related 4G cellular technology R&D engineers in Finland (formerly employed by the Finnish arms of Nokia, Ericsson, Motorola, and Broadcom (see [ULP Wireless Q Spring 2016 pg16](#))) the company is busy developing solutions for the emerging IoT sector.

A key requirement for the IoT is low complexity, low cost communication devices with long battery life and good coverage over long range, even in the most challenging locations. The strategy adopted by Nordic is to base solutions on the established foundation of cellular networks - which already cover the globe with secure, reliable mobile access based on international standards. 'Low power cellular IoT' can build on this infrastructure while meeting low-cost, low-power, and long-range demands.

"In wireless, LTE is about as complex and specialized as it gets," explains Svein-Egil Nielsen,



*"Nordic's objective is to shape the future of low power cellular IoT"*

CTO of Nordic. "There's probably only a handful of teams in the world with the capability and track record to develop and deploy such a technology. We have one of those teams and as a company our objective is to shape the future of low power cellular IoT in exactly the same way we did for ultra-low power wireless and Bluetooth low energy."

## A market in its infancy

Nordic's strategy highlights its plan to complement the company's class-leading Bluetooth low energy, ANT, and proprietary short-range ULP wireless technology with long-range, low power technology to target new high growth markets. The recently-released roadmap for low power cellular IoT technology outlines highly-integrated nRF91 Series chipsets and associated software that adheres to the 3GPP (3rd Generation Partnership Project) Release 13 LTE-M and NB-IoT cellular technology standards.

"The cellular IoT market is still in its infancy and new

low power LTE technology variants will drive growth in the same way that Bluetooth low energy is doing for short-range wireless," explains Thomas Embla Bonnerud, Director of Strategy and Investor Relations with Nordic Semiconductor. "Some years down the road this market is going to look very different. The nRF91 Series is a new and different solution for that new and different market." (See *this issue pg 9*.)

3GPP is a collaboration between telecoms partners which is, in part, tasked with the development and maintenance of LTE and related 4G cellular standards. Release 13, nearing completion, details the latest specifications for developers designing products for LTE and 4G applications. LTE-M (LTE-Machine-to-Machine (M2M)) is a 'variant' of LTE cellular technology specifically designed to meet the cost, power, and range requirements for M2M IoT applications. And NB-IoT (Narrow Band-IoT) is another 3GPP administered technology,

also using LTE infrastructure, which according to the 3GPP "will provide for better indoor coverage, low latency, low device cost, and a massive number of connected devices" using low-power sensors sending relatively small amounts of data.

Nordic says the nRF91 Series chipsets will be optimized for power and size, and designed specifically to address the needs of low power cellular IoT applications, including long battery life, low cost deployment and maintenance, scalability for many devices, and ubiquitous network coverage. Nordic expects to sample the first nRF91 Series solutions to selected lead customers during the second half of 2017, with broad availability and production ramp following in 2018.

The low power cellular IoT market is projected to surpass 1.5 billion connections by 2021. Nordic expects initial coverage for LTE-M and NB-IoT technologies to start in 2017 with more widespread coverage during 2018 and 2019. ■

# The promise of low power cellular IoT

The latest LTE standard includes a specification for low power cellular technology which will accelerate development of the IoT, says Thomas Embla Bonnerud



**Thomas Embla Bonnerud** is Director of Strategy and Investor Relations with Nordic Semiconductor

Long Term Evolution (LTE) is a standards-driven technology for high-speed cellular connectivity, designed to provide high-bandwidth communication for mobile devices.

The LTE standard is managed by the 3rd Generation Partnership Project (or [3GPP](#), comprising a collaboration between telecoms partners) and was first specified in the organization's Release 8 document with enhancements added in Release 9. Since then, LTE has been adopted by most of the international cellular service providers ('carriers') including those in North and South America, Europe, Russia, India, China, Korea, and Australia. The standard covers a number of frequency bands in the 700 to 2600 MHz range to facilitate its use by carriers in different regions.

Internet access using a cellphone connected via LTE is something consumers take for granted. It's a simple step, therefore, to imagine a world where the emerging Internet of Things (IoT) also leverages such technology to connect billions of sensors to an expanding network. It's a much harder step to make it happen. But now, 3GPP is tackling the challenge head-on by introducing enhancements to the LTE specification that will allow pioneering companies such as Nordic Semiconductor to come up with practical 'low power cellular IoT' solutions.

## From LAN to WAN

Today it's relatively simple—courtesy of technology developed by companies like Nordic—to connect a Bluetooth low energy-powered sensor to the IoT, provided a smartphone or Wi-Fi router is available to act as a 'gateway' to the network. Such



**A major advantage of low power cellular IoT is that the supporting infrastructure is already in place even in remote areas of the globe**

Local Area Networks (LANs) are commonplace in homes and offices. But for the enterprise, industrial, and agricultural sectors among others, things can be more of a challenge because in many applications the sensors—particularly if they are attached to an object that's on the move—could be out of range of a LAN.

Cellular technology is a proven way to directly connect remote devices to the Internet in the absence of a LAN, and a healthy industry has grown supplying modules using 2G and 3G technology for Wide Area Network (WAN) applications such as Machine-to-Machine (M2M) communications.

Unfortunately, the modules are expensive (\$30 to \$40 for 3G devices), bulky, and consume lots of power so are poorly suited to multi-billion installation applications such as sensors used for parcel tracking. As a result, there's increasing demand across a broad market for low-cost (sub-\$5), compact, microampere LTE modules that support 'Low Power WANs' (LPWANs).

Further, carriers are keen to encourage low-power, low-data rate devices because they have the bandwidth to accommodate extra data alongside the high-demand traffic transported over their networks. Such business promises to provide a welcome

new revenue stream to offset the huge costs incurred by the carriers when buying parts of the radio spectrum.

To meet this groundswell, 3GPP has introduced a specification for two forms of low power LTE—[LTE-M](#) (for M2M) and Narrow Band-IoT (NB-IoT)—detailed in Release 13 of the standard. LTE-M specifies a low-complexity modem enabling simpler, reduced cost, and lower power LTE devices to be developed with peak uplink and downlink data rates of approximately 300 kbps, RF bandwidth support of 1.08 MHz, and 20 to 23 dBm transmit power.

NB-IoT features an RF bandwidth of 180 kHz with peak data rates of approximately 30 kbps. Transmit power remains at 20/23 dBm. Both LTE-M and NB-IoT devices will have a range

*“Only a handful of companies have the engineering capability to design LTE wireless and even fewer have the complementary expertise needed to develop low power cellular IoT devices”*

of tens of kilometers and battery life of at least several years.

There are competing technologies, but a major advantage of LTE-M and NB-IoT is that the supporting infrastructure is already in place across the majority of the globe. In contrast, competing technologies are faced with billion-dollar, multi-year building programs to assemble equivalent infrastructure.

From specification to commercial product is a long road. Some companies have announced products for volume production in 2017 to coincide with first commercial deployments of the enhanced cellular infrastructure required to support low power cellular IoT. Broad coverage of this infrastructure will occur between 2017 and 2020. Nordic is planning its product introduction to coincide with this schedule.

But perhaps more significantly, only a handful of companies have the engineering capability to design LTE wireless (which is a complex technology) and even fewer have the complementary expertise needed to develop low power cellular IoT devices.

Nordic is one of those companies. Not only does the company have over a decade of leadership in ultra low power wireless—culminating in the company's latest class-leading [nRF52 Series](#) Bluetooth low energy SoCs—but it also has an engineering team in Finland comprising several of the engineers that were responsible for many of the inventions that underpin LTE technology.

It's an exciting combination of skills and the engineers are working on the products outlined in Nordic's roadmap for the nRF91 Series low power cellular IoT solutions. (See *this issue* pg8.) These products will meet the demands of the rapidly evolving IoT landscape. It's a landscape that will look very different in just a few years time. ■



# New Android OS strengthens security for Touch-to-Pair

Android 7.0 Nougat's support for out-of-band method pairing with NFC for Bluetooth devices retains touch simplicity but enhances protection. Pär Håkansson explains



**By Pär Håkansson,**  
Product Marketing  
Manager, Nordic  
Semiconductor

One of the key enhancements between Nordic Semiconductor's nRF51 Series and nRF52 Series Bluetooth low energy Systems-on-Chip (SoCs) is the incorporation of an on-chip Near Field Communication (NFC)-A tag for **consumer friendly** "Touch-to-Pair". The functionality allows consumers to pair, for example, Nordic-equipped Bluetooth low energy devices and Bluetooth 4.0 (and later) smartphones (that feature NFC) by bringing them together.

NFC is a contactless RF technology that enables devices to share information at a distance of less than 10 cm. The technology's bidirectional communication employs electromagnetic induction between two loop antennae to exchange information and takes less than one tenth of a second to establish a connection between two devices.

The NFC technology incorporated into the nRF52 Series SoCs completes the steps of enabling, pairing, and establishing the Bluetooth low energy connection with no user intervention. Once the NFC connection has completed the pairing, Bluetooth low energy takes over - enabling rapid information transfer over tens of meters. ([See ULP Wireless Q Winter 2015 pg9.](#))

Conventionally, discovering a Bluetooth-enabled device typically uses the "Inquiry" procedure for Bluetooth 4.0 (and later) devices and the "Discovery" procedure for Bluetooth low energy devices



**Touch-to-Pair has become more secure with Android's latest OS release**

*"Because the nRF52 Series incorporates a dynamic NFC tag, the additional cost for a developer to add NFC pairing to a Bluetooth low energy product is very low"*

to establish if other Bluetooth devices are in close proximity. The user is then required to select a device from a (potentially long) list of alternatives and pair by typing in a passkey.

NFC makes life easier by eliminating Bluetooth technology's Inquiry or Discovery procedure by communicating and authenticating the Bluetooth address (and other optional parameters) of the specific device that is brought together with the host.

Because the nRF52 Series incorporates a dynamic NFC tag, the additional cost for a developer to add NFC pairing to a Bluetooth low energy product is very low; all that's required

is the addition of two small passive components and an NFC antenna. Everything else is included in the SoC as standard.

## What's new in Android?

NFC pairing has now got even better for users of Android-powered mobile devices upgrading to the latest release of the Android OS, Android 7.0 Nougat. [Android Nougat](#) doesn't introduce dramatic changes to the mobile device OS, rather it tidies up previous versions and introduces some subtle new features including support for Bluetooth pairing with NFC using the out-of-band (OOB) method.

OOB communication implies that information for the pairing

process is transferred using an external (non-Bluetooth) technology, such as NFC. The benefit of the OOB method is that it brings security to the Touch-to-Pair process without adding any complexity for the user such as typing in a passkey.

Previous versions of the Android OS didn't send the security key ("TK Value" in the Bluetooth Core Specification) over NFC, rather the OS paired using the "just works method". While this made the Touch-to-Pair process very simple it did nothing for security because the just works method uses an encryption key with all values set to zero. This basic encryption status makes the pairing process vulnerable to eavesdropping attacks.

Things are much improved with Android Nougat's use of the OOB method because a 16-Byte temporary key, sent over NFC, is used to generate (non-zero) encryption keys used later in the pairing process. The encryption protects against eavesdropping with the added bonus that the very short range of NFC makes interception of the signal between devices almost impossible.

Nordic's latest nRF52 Development Kit (DK) and nRF5 Software Development Kit (SDK) enable developers to evaluate the advantages of secure NFC Touch-to-Pair implemented with the nRF52 Series SoCs and Android Nougat. The kits include examples demonstrating secure NFC pairing as well as other things that can be done with NFC (see video here <http://tinyurl.com/gmakc65>). The Nordic examples of NFC pairing using the OOB method actually predate Android Nougat and have now been shown to work seamlessly with the OS with little or no developer input. ■



# Preparing for Bluetooth 5.0

Developers will take advantage of Bluetooth technology's coming enhancements as soon as chip vendors can supply upgraded products. By Caroline Hayes



**Caroline Hayes**  
is a U.K.-based  
technology  
journalist

Advances to Bluetooth low energy technology will be announced late 2016, early 2017, when the Bluetooth Special Interest Group (SIG) formalizes Bluetooth 5.0. The [revised specification](#) will offer a quadrupling of range for Bluetooth low energy devices compared to the Bluetooth 4.0 standard and will double the speed of data throughput from 1 to 2 Mbit/s.

Because the Bluetooth SIG is keen to retain the low power consumption for which Bluetooth low energy technology was specifically designed, range and data rate are a trade-off. Engineers can choose the trade-off that suits their application. For example, a medical device developer might wish to take advantage of the 2 Mbit/s data rate and accept a reduced range, while a smart light designer might wish to boost range to 50 meters or more while working with a data rate of 250 kbit/s. ([See ULP Wireless Q Winter 2015 pg10.](#))

"Doubling the throughput is significant," says John Leonard, Product Marketing Manager, Nordic Semiconductor. "It enhances functions that are time-consuming at present, due to the bandwidth limitations, for example, over-the-air upgrades. Using Bluetooth 5.0 technology, faster software and firmware updates will be particularly beneficial in wearable products and desktop peripherals because they will become much more convenient for consumers."

## Quick response

When the Bluetooth 5.0 specification is adopted by the Bluetooth SIG, developers will want to take advantage of the functionality it offers, and



The rapid over-the-air firmware updates facilitated by Bluetooth 5.0 will increase convenience for wearable users

*"As well as executing actions quicker in existing applications, Bluetooth 5.0 products will also compete with Wi-Fi products in some applications, opening up new possibilities"*

implement designs as soon as possible. As a leading Bluetooth low energy solutions vendor, Nordic Semiconductor plans to be quick off the mark.

Shortly after the specification is announced, Leonard believes developers using Nordic technology will be able to take advantage of the enhancements to the standard.

"We are working hard to have all the software in place to deliver as soon as possible [after the specification is adopted] for

people to start implementing the features in applications and products," says Leonard. "That will include support software, protocol stacks, and software development kits [SDKs]."

The radio architecture of Nordic Semiconductor's [nRF52](#) Series Systems-on-Chip (SoCs) already supports the increased throughput rate of Bluetooth 5.0. The SoCs can offer increased range by offering stepped-down data rates to ensure power consumption is not



Smart lighting will benefit from increased range under Bluetooth 5.0

compromised. Leonard points out that it is sufficient for a device to support just one aspect of the specification to be categorized as "Bluetooth 5.0".

Chips to support the full range of features will follow "hot on the heels" of Bluetooth 5.0's adoption, assures Leonard, with software to complement the hardware introductions. The next nRF52 SoC upgrade, for example, will comply fully with all the enhancements detailed in the new Bluetooth specification.

The increase in data throughput and range offered in the new specification will appeal to consumers. As well as executing actions quicker in existing applications, the enhancements will enable Bluetooth 5.0 products to compete with Wi-Fi products in some applications, opening up possibilities for many new products.

Many industrial applications, do not require high data throughput, so will capitalize on the extended range that Bluetooth 5.0 brings. Bear in mind, says Leonard, that the enhancements brought by Bluetooth 5.0 are not mutually exclusive, and that if there is a need for a firmware upgrade, for example, a device can switch from long range to high data throughput mode to accelerate the update and then switch back again for application use.

Ahead of the Bluetooth 5.0 specification being announced, Leonard is confident Nordic will retain its pioneering record in Bluetooth low energy technology: "Nordic had the first Bluetooth low energy part, was the first company with an SoC integrating a 32-bit ARM Cortex processor, the first with a multiprotocol device, and the first to offer over-the-air firmware upgrades," he points out.

"It won't be long after Bluetooth 5.0 is adopted that Nordic will be supporting it in its products." ■

# Ultra low power wireless connectivity solutions

Find the chip you need using this latest listing of every Nordic product

ICs	Operating Band	Wireless Protocol	IC Type			On-Chip				Peripherals														Applications										Ref. Designs	Dev Tools	WLCSF Wafer-level chip-scale package option							
			System-on-Chip	Connectivity	Transceiver	CPU	FPU	DSP	Memory OTP: One Time Programmable	MPU	Balun	Oscillators	NFC-A tag	2-Wire	ADC	AES	Analog Comparator	Battery Monitor	I2S	PDM	PWM	Real Time Clock	RNG	SPI	S/PDIF	Temperature Sensor	UART	USB	PC Peripherals	Sports & Fitness	Gaming	Cellphone Accessories	Consumer Electronics				Automation	Healthcare	Toys	Wearables	Smart Home	Beacon	Wireless Charging
<b>nRF52 Series</b> +																																											
nRF52832	2.4GHz	Bluetooth low energy 4.2, Proprietary & ANT	•	•		Cortex M4F	•	•	64kB RAM 512kB Flash	•	•	32MHz / 32kHz Crystal 64MHz / 32kHz RC	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	-	Single Board Dev Kit	•		
<b>nRF51 Series</b> +																																											
nRF51822	2.4GHz	Bluetooth low energy 4.2 & Proprietary	•	•		Cortex M0			32kB or 16kB RAM 128kB or 256kB Flash	•		16MHz / 32kHz Crystal 16MHz / 32kHz RC	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	PC Desktop, Smart Remote, Smartphone Demo Apps, Beacon	Single Board Dev Kit, Dongle	•	
nRF51422	2.4GHz	Bluetooth low energy 4.2, Proprietary & ANT	•	•		Cortex M0			32kB or 16kB RAM 128kB or 256kB Flash	•		16MHz / 32kHz Crystal 16MHz / 32kHz RC	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Smartphone Demo Apps	Single Board Dev Kit, Dongle	•	
nRF51824	2.4GHz	Bluetooth low energy 4.2 & Proprietary	•	•		Cortex M0			16kB RAM and 256kB Flash	•		16MHz / 32kHz Crystal 16MHz / 32kHz RC	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Smartphone Demo Apps	Single Board Dev Kit, Dongle	•	
<b>nRF8000 Series</b> +																																											
nRF8001	2.4GHz	Bluetooth low energy 4.0	•	•		-			-			16MHz / 32kHz Crystal 32kHz RC											•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	PC Desktop, Smart Remote, Smartphone Demo Apps	nRFgo Dev Kit, Prog. Kit		
nRF8002	2.4GHz	Bluetooth low energy 4.0	•	•		-			-			16MHz Crystal 32kHz RC																											Key Tag, Smartphone Demo Apps	nRFgo Dev Kit, Prog. Kit			
<b>nRF24AP Series</b> +																																											
nRF24AP2-1CH	2.4GHz	ANT	•	•		-			-			16MHz / 32kHz Crystal																											Smartphone Demo App	ANT Dev Kit			
nRF24AP2-8CH	2.4GHz	ANT	•	•		-			-			16MHz / 32kHz Crystal																												Smartphone Demo App	ANT Dev Kit		
nRF24AP2-USB	2.4GHz	ANT	•	•		-			-			16MHz Crystal																												ANT USB Dongle	ANT Dev Kit		
<b>nRF24L Series</b> +																																											
nRF24LE1	2.4GHz	Proprietary	•	•		8051			1kB + 256B RAM 16kB + 1.5kB Flash			16MHz / 32kHz Crystal 16MHz / 32kHz RC	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	PC Desktop, Smart Remote, R/C Toy	nRFgo Dev Kit, Prog. Kit	
nRF24LE1 OTP	2.4GHz	Proprietary	•	•		8051			1kB + 256B RAM 16kB + 1kB OTP			16MHz / 32kHz Crystal 16MHz / 32kHz RC	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	PC Desktop, Smart Remote, R/C Toy	nRFgo Dev Kit, Prog. Kit	
nRF24LU1+	2.4GHz	Proprietary	•	•		8051			2kB + 256B RAM 16/32kB Flash			16MHz Crystal																												PC Desktop, Smart Remote, R/C Toy	nRFgo Dev Kit, Prog. Kit		
nRF24LU1+ OTP	2.4GHz	Proprietary	•	•		8051			2kB + 256B RAM 16kB + 1kB OTP			16MHz Crystal																													PC Desktop, Smart Remote, R/C Toy	nRFgo Dev Kit, Prog. Kit	
nRF24L01+	2.4GHz	Proprietary		•		-			-			16MHz Crystal																													-	Eval Kit	
<b>nRF24 Series</b> +																																											
nRF2460 (mono)	2.4GHz	Proprietary	•	•		-			-			16MHz Crystal	•																												Microphone	nRFgo Dev Kit	
<b>nRF900 Series</b> +																																											
nRF90E5	Sub 1-GHz	Proprietary	•	•		8051			4kB + 256B RAM			4 / 8 / 12 / 16 / 20MHz Crystal																													-	Eval Kit	
nRF905	Sub 1-GHz	Proprietary		•		-			-			4 / 8 / 12 / 16 / 20MHz Crystal																													-	Eval Kit	

# Enhancing asset tracking with ultra low power wireless

Wireless technology has reinvented asset tracking systems by incorporating them into the Internet of Things. By Sally Ward-Foxton



**Sally Ward-Foxton** is a freelance journalist specializing in electronics

Asset tracking is a tantalizing application for wireless technology, with the potential to be an absolutely huge and diverse market. Stretching from checking out library books, to tracking fragile parcels around a global logistics network, to monitoring products around the assembly line during manufacture, to locating portable medical equipment in a hospital campus, asset tracking encompasses so many different use cases that there's no single wireless technology or protocol suitable for all.

Many different technologies have been used in tracking applications to date. For example, many asset tracking applications, such as retail goods, rely on passive radio frequency identification (RFID) tags which include a small wire antenna connected to a chip containing basic data such as a tag number. Newer forms of RFID technology, such as Near Field Communication (NFC) are also used for asset tracking, though they are typically limited to applications such as checking inventory in and out, since a person has to physically hold a reader next to the tag to read it. Mobile logistics tracking applications use a GPS chip alongside a GSM/cellular modem embedded into pallets to send messages via the mobile phone network as they move around a distribution network. The drawbacks include modem cost and relatively short battery life.

Around ten years ago, Wi-Fi tags emerged as a potential solution for high-end asset



Bluetooth low energy asset trackers allow seamless smartphone and tablet connectivity, supporting a wide range of logistics applications

*“Smartphone connectivity is essential for our customers,”*

*Ozan Can Köseley, Tag2Sense*

tracking. Wi-Fi tags determine their location using methods like triangulation of RSSI (received signal strength indicator) measurements from nearby access points in known locations. Since most offices and businesses have Wi-Fi networks already set up, location data can easily be created and collected without any additional infrastructure. The trouble with systems like these is that because the tags are active, they need batteries, and although the situation has improved compared to ten years ago, Wi-Fi is still pretty power hungry. In a big hospital with 1000 pieces of equipment being tracked, many hours would be required to change all the batteries every few months.

This is where ultra low power wireless communication protocols like Bluetooth low energy gain an advantage. Bluetooth low energy is efficient

enough to enable active asset tracking tags with small coin cell batteries that can last for years. The range of this technology is tens of meters, connecting all the items on (say) a warehouse shelf or a particular pallet to the Cloud via a nearby ‘gateway’ such as a router. This gives inventory and stocktaking processes a degree of automation instead of having a person go around and physically scan every item with a reader. The range of Bluetooth low energy is set to improve to as much as several hundred meters with the next version of the technology (Bluetooth 5.0) which would potentially allow communication with all the tags in a warehouse from one gateway. (See this issue pg11.)

## At a glance

- **Asset tracking is a huge, diverse market. Modern wireless technology and the Cloud are revolutionizing the sector**
- **Bluetooth low energy is a good fit for asset tracking, given its beacon mode, low power operation, and range**
- **Proprietary protocols still thrive in this sector as they can be tailored for specialized applications**

Bluetooth low energy's beacon capability is also perfect for asset tracking applications. This feature enables small Bluetooth low energy devices in specific locations (the beacons) to broadcast packets of information ready for other Bluetooth-enabled devices, such as smartphones, to pick up as they pass by that location. An asset tracking system could use beacons as tags, with a network of gateways receiving the location data. Or, tracked items could record which locations they pass by in a warehouse kitted out with a network of beacons.

## Tracking conditions

Many companies are taking advantage of the favorable features of Bluetooth low energy technology, along with the rapidly decreasing cost of Bluetooth low energy chips, to enable new asset tracking platforms.

[Tag2Sense](#), based in Turkey, has commercialized a Bluetooth low energy-based asset tracking system using Nordic Semiconductor's [nRF51822](#) System-on-Chip to monitor the environmental conditions experienced by fragile or perishable goods in transit. The platform uses data logging sensor tags, which can include up to five different types of sensor to monitor temperature, humidity, light, shock and/or pressure. These tags are battery powered and can last six months in normal operation (logging data from five sensors every 30 seconds), or up to two years in economy mode. They are connected to the Cloud via the company's gateway, the Tag2Sense Bridge. Alternatively, since Bluetooth low energy capability is widespread in portable devices, they can be read by almost any recent-model smartphone or tablet using the Tag2Sense app.

"[Bluetooth] smartphone connectivity is essential for our customers," says Ozan Can Köseley, Business Development Director at Tag2Sense. "[For example] one of our Turkish pharmaceutical clients sends goods to the United States and their customers are very sensitive about the environmental

conditions that occurred between the factory and the end point, since the product's quality can be affected by conditions like temperature. The customer uses our Tag2Sense mobile app to gather data and accelerate the process of product acceptance," he explains. "Our customer was able to see the data logged when the goods were in customs, as it is transferred to the web-based application - both producer and customer can have the same information in real-time."

Further, the Tag2Sense platform can be used to record when a tracked item enters a particular warehouse or lorry. Beyond that, Tag2Sense can also use the Bluetooth signals' RSSI to locate tracked items within a warehouse or factory, feeding the relative signal strengths into a Cloud-based algorithm to work out how far from the Tag2Sense Bridge the tag is.

## Proprietary protocols

Proprietary wireless protocols developed especially for asset tracking are also finding commercial applications, particularly in situations where Bluetooth low energy currently can't handle the number of tags or the range requirement. Swedish technology company [Free2Move](#) has developed the 2Connect asset tracking



**A Tag2Sense asset tracking data logger contains five sensors to monitor the environmental conditions experienced by shipments in transit**

platform, a complete Internet of Things (IoT) architecture which uses the company's proprietary Free2Move Radio Air Protocol (FRAP) on its 'Celebes' wireless gateway for tracking very large numbers of items simultaneously.

"FRAP is specialized for cases when you have a very high number of sensors per gateway, and need high robustness and security in the wireless links," says Martin Harnevie, Director of Marketing at Free2Move. "There are cases in our airport installations where one single Celebes gateway robustly handles up to 3000 airport trolleys at the same time with the FRAP protocol. This level

of performance is absolutely instrumental for these sorts of applications; it is not uncommon for a machine parts warehouse to store 40,000 to 50,000 items at any one time, for example."

Celebes connects with a range of devices, sensors, beacons and actuators supplied by Free2Move. Using these, the 2Connect platform can perform environmental monitoring as well as asset tracking.

Harnevie says while future versions of the 2Connect platform will continue to use FRAP, they may take advantage of some of Bluetooth technology's features, too. Migration to Bluetooth low energy is made easier by the company's choice of Nordic's [nRF52832](#) SoC which is equally adept at handling Bluetooth low energy and proprietary protocols; there are very few ultra low power chips able to do this.

"We foresee applications where we will introduce Bluetooth when we need to incorporate third party products, communicate directly with mobile phones, or use certain GATT [Generic Attribute] profiles which FRAP doesn't support," Harnevie says, citing Bluetooth 4.2 and 5.0's increased packet size as an important parameter. "FRAP and Bluetooth can work concurrently in the [Nordic Semiconductor nRF52832 SoC used in the Celebes gateway] and play to one another's strengths."

The emergence of ultra low power wireless technologies such as Bluetooth low energy, combined with advances in back-end systems integration and the easy accessibility of the Cloud, has revolutionized asset tracking offerings. New, low power, active asset tracking tags are taking advantage of the rapidly decreasing cost of Bluetooth low energy chips with integrated processors, such as the nRF51822 and nRF52832 Bluetooth low energy SoCs. As the cost and power consumption of these devices continues to reduce, asset tracking will continue to expand into cost-sensitive applications, as well as replacing passive tags in applications that can make use of active tags' added intelligence. ■



**The Free2Move Celebes gateway is used for building monitoring and asset tracking as part of the company's complete IoT architecture**

# Toys 2.0: Connectivity comes to the rescue

Technology, widely predicted to spell the end of traditional toys, is actually leading to their resurgence. ULP Wireless Q reports

**R**ichard Gottlieb has worked in the toy industry for much of his adult life. As President of New York-based toy industry consultancy, Global Toy Experts, Gottlieb helps toy manufacturers of all sizes and persuasions increase market share. There are few that know the industry as intimately.

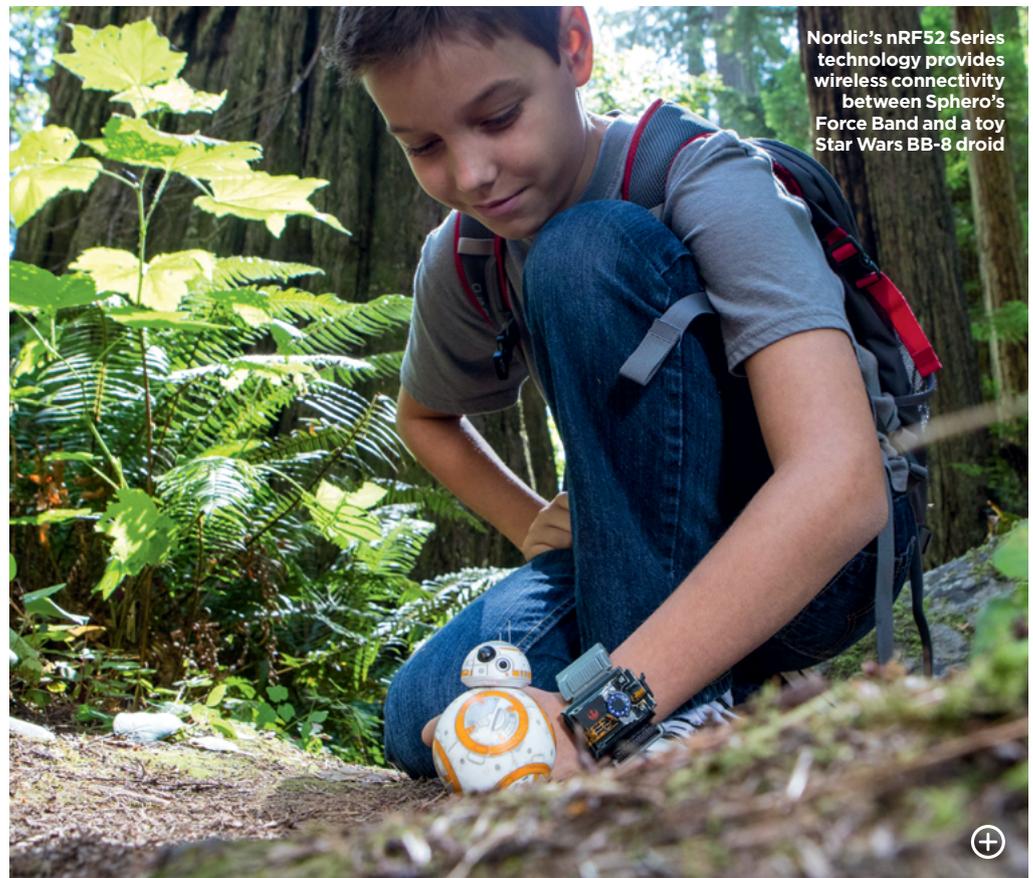
Last year, speaking to the *New York Times*, Gottlieb observed: “[Toys are] essentially a 19th century industry desperately trying to break into the 21st.” The toy industry, he says, had seen its fortunes gradually eroded in recent years, but there was now a sign of a turnaround thanks to media convergence—toys merging with content via movies, television, apps, and YouTube—and, crucially, technology.

Incorporating wireless connectivity into toys, alongside Bluetooth connectivity in mobile devices, has created a new category of highly engaging and feature-rich toys which are winning over a new generation of tech-savvy children, at the same time reinvigorating toy categories that not long ago appeared destined for extinction.

## Back on track

This is no better illustrated than in the model railroad toy market. This quintessentially 20th century pursuit was thought to be reaching the end of the line, shunted off into history now that the majority of enthusiasts are entering their twilight years.

However, one of the world’s oldest traditional model railroad manufacturers, Philadelphia-based [Bachmann](#) Trains, is proving there is life in the sector yet, introducing wireless smartphone and



Nordic’s nRF52 Series technology provides wireless connectivity between Sphero’s Force Band and a toy Star Wars BB-8 droid

SPHERO, STAR WARS® AND™ LUCASFILM

tablet touchscreen control and app-based interactivity, via its ‘E-Z app’ system. Bachmann developed E-Z App in conjunction with Bluetooth model train PCB design specialist, BlueRail Trains, using Nordic Semiconductor nRF51822 System-on-Chip (SoC)-based BMD-200 modules from U.S. engineering firm Rigado.

According to Rich Janyszek, Senior VP of Sales & Marketing at Bachmann, the incorporation of ‘smart’ technology could represent the biggest leap for the industry since digitization was introduced in the 1980s.

“We think this technology

provides an open door for new and perhaps non-traditional customers,” says Janyszek.

“Pairing a traditional toy with modern touchscreen control and brand new app-based interactivity will attract technology-driven users of all ages, and could propel model railroading in brand new directions that before now wouldn’t have been possible.”

It’s a similar story in the slot car rise and fall largely mirrored that of model railroading; born in the first half of the 20th century, reaching peak popularity in the

1970s, before struggling to retain the interest of children in the era of digital games. Now wireless connectivity is breathing new life into the toy car industry thanks to pioneers like British global toy giant, Hornby Hobbies, and its iconic slot car division, [Scalextric](#).

Scalextric’s ‘App Race Control’ (ARC) comprises a range of Nordic nRF51822 SoC-powered plug-and-play ‘Powerbase’ accessories that allow users to wirelessly create and manage races via an app running on a compatible Bluetooth device. The app offers race statistics and supports realistic pit lane

functionality that can directly affect the performance of the slot car, for example customized throttle response.

Scalextric has also developed 'Hand Throttle' wireless controllers that employ proprietary Nordic nRF24LE1 2.4GHz SoCs to provide the wireless connectivity between the controller and the Powerbase track accessory. The result is a famous 20th century brand winning over a legion of new 21st century fans by applying wireless technology.

"Since the launch of the Scalextric brand in 1957, we have amassed a significant consumer base," says Ricky Black, Marketing Manager at Scalextric. "With the addition of a single Powerbase track, existing consumers can suddenly bring their Scalextric straight into the 21st century with racing features and statistics that even a few years ago would have been considered impossible to achieve on a mass-market consumer toy product."

## Augmented reality

It's not just traditional toy segments that are benefiting from wireless connectivity. U.S. connected play company Sphero is the perfect illustration of media convergence integrating with technology to reimagine the toy sector for a 21st century consumer in the form of nothing less than a wearable.

Sphero recently unveiled its 'Force Band' wrist-worn wearable toy based on the 'Star Wars' film franchise, allowing the wearer to wirelessly control Sphero's range of robots—including the Star Wars 'BB-8 droid'—via gesture recognition, mimicking 'The Force', the telekinetic power of the film's chief protagonists the 'Jedi Knights'.

The Force Band employs a Nordic [nRF52832](#) SoC to support the intensive computational requirements of the wireless application. Once the Force Band and the BB-8 droid are paired, the Bluetooth low energy connection provides bidirectional communication between the wrist-band and the robot, with a six degrees of freedom accelerometer/gyro



On your marks: slot car racing is enjoying a revival

*"Pairing a traditional toy with touchscreen control and app-based interactivity will attract technology-driven users of all ages"*

in the wrist-band detecting the Force Band wearer's wrist movements which in turn control the robot's specific movements. The result is a connected play and augmented reality toy that promises to be a best seller.

Virtual reality (VR) is another 'hot' toy and gaming market segment making significant leaps forward. VR has been evolving

since the 1990s, but the truly immersive experience many imagined 20 years ago is only now finally coming to fruition with the introduction of 'active VR', powered by Bluetooth low energy technology.

One pioneer of active VR—where your actions in the virtual world are controlled by first person navigation—is [Virtuix](#). The

Active VR in every household is Virtuix's goal



Texan company's Virtuix Omni VR motion gaming platform has revolutionized the gaming segment, allowing the player to use their whole body to control their actions with 360° freedom of movement.

The technology involved to bring the gaming experience to life is startling, employing up to 16 wearable sensor modules—each powered by a Nordic nRF51822 SoC—to communicate wirelessly with the unit's sensor hub, where in turn the data is transferred to a wireless headset and to a host application running on a Bluetooth device or via USB cable to a PC.

The key challenge for Virtuix was latency. In a man/machine system like a VR motion sensor, the system's latency needs to be low enough that it isn't perceptible to an average human user. Virtuix figured its system needed to react in 150 milliseconds or less, a target it achieved by designing its own 2.4 GHz protocol based on Nordic's Gazell RF protocol software with low latency yet with a power consumption comparable to Bluetooth low energy. The result is an active VR experience that children (and adults), hungry for a truly immersive gaming environment, haven't previously been able to enjoy.

"The Omni in its current shape is still fairly large, it's fairly expensive, and it's not for everyone just yet, but we are working hard to reduce the cost and size," says Jan Goetgeluk, CEO, Virtuix. "Ultimately our vision is to provide the Omni at a price point and a form factor that allows active VR for everyone."

The technology may not be fully refined yet, but it's still impressive and developing rapidly, and whether it's 'old school' pastimes like model railroads and slot cars, or more recent gaming developments like wearables or active VR, the future is here. Children always have, and always will need entertainment in the form of toys and games. As for that matter so will grown-ups. And technology in general, and wireless connectivity in particular, will be critical to the industry's health. Toys 2.0 is upon us. ■



# Runners adopt power monitoring

Kat Kent explores the advanced sensors that are improving runners' workouts

**Stryd power meter takes advantage of a highly-integrated wireless SoC to reduce the device's form factor**



**Kat Kent** is a Canada-based technology journalist and a wireless applications engineer

Running footpods were among the earliest wearables to be developed, but other than becoming smaller, lighter, and more accurate, not much about them changed in the decade following their adoption. Development focus shifted to other sports, because knowing speed, distance, and heart rate was perceived to be all that was needed by runners, many of whom loved the simplicity of running as a form of active meditation.

But as the world of wearables grew, and the landscape changed around runners to include ways to log, share, and analyze their current performance, the idea of running faster, stronger, and better took hold. Training plans based on pace and heart rate zones are standard in running today, but they are steadily being augmented and/or replaced by a host of new metrics that have become

available in recent years. Running power is chief among them.

According to Olympic running and triathlon coach, Bobby McGee: "The holy grail in running has been to discover such a factor - measuring power in running as a unit." Knowing running power enables athletes to compare their effort across runs more effectively. For example, running uphill or into a wind requires more power to maintain the same pace. Similarly, running on softer surfaces will burn more power than running on asphalt. Monitoring heart rate gives an indication of how hard an athlete is working and will therefore remain a key figure for serious athletes to monitor. However, the power measured by running power meters does not include any lag, and makes it easier to see why the heart rate has started to rise. Being instantaneously responsive, power monitoring also enables athletes to see the effect of changes to their running form in real time, thus helping them pursue greater efficiency.

Early prototypes and Kickstarter projects have

produced advanced running power sensors that function, although a fully interoperable end-to-end solution is lacking. Instead of using a regular sportswatch or smartphone app to connect with the sensor, the download of a proprietary app is needed, as is the tedium of a multistep process to add running power data alongside other metrics in popular apps such as TrainingPeaks or Garmin Connect. Alternatively, for running power meters, the user can set their watch into cycling mode and upload data normally, and then edit later to show up as a running session. Neither of these approaches make for a great user experience, or encourage adoption of the new metric.

Until now. As Dirk Friel, co-founder of TrainingPeaks puts it: "It looks like the future has arrived, a power meter for runners that will advance training methods by decades".

## Towards interoperability

That future comes in the form of an end-to-end solution that works for runners. Last year, Athlete Architect, a Boulder, CO-based

technology-centered sports and fitness company, launched [Stryd](#), a wearable device for measuring running power. The device offered both ANT+ and Bluetooth low energy wireless connectivity, using Nordic Semiconductor's nRF51422 multiprotocol System-on-Chip (SoC). This August, the company will be relaunching its running power meter.

Stryd has been completely redesigned, and will now be worn on the runner's shoe, rather than clipped to the back of their shorts as the earliest versions were. More importantly, from a use case perspective, it is being launched complete with a Connect IQ app, which once downloaded onto a compatible Garmin watch, will mean users can keep the watch in run mode and see their real time power number on the screen as they work out. Stryd promises a solution that fits with a runner's existing products and habits.

Stryd demonstrates that one option developers have is to wirelessly transmit data from their running power monitors. While no ANT+ or Bluetooth low energy profile specifically designed to



transmit running power data has been published, a solution based on the ANT+ Bike Power Device Profile or the Bluetooth low energy Cycling Power Profile works well and offers the best opportunity for users to see their data on existing displays.

It's also possible to interleave manufacturer specific data pages to transmit advanced metrics such as pronation angle and leg stiffness. However, until these additional metrics are more widely adopted and standardized, then proprietary apps will be needed to display the data.

If a sport indicator was added into the ANT+ or Bluetooth low energy cycling power profiles, manufacturers could enable sensors to indicate to displays for which sport they are being used. This would be particularly useful for multisport power meters, such as RPM2's product, that can measure both running and cycling power. (RPM2's device is built into a pair of insoles that measure force and transmits total power, left-right power, and bilateral equivalency among other metrics.)

Alternatively, if the device is intended to operate in a closed ecosystem of devices, then manufacturers are free to define their own transmission protocol and send the data on a private ANT network. DorsaVi is an example of such an ANT-based multisensor system and is used to analyze sophisticated



Running power enables athletes to compare their effort more precisely across varying terrain

biomechanical parameters during running. DorsaVi requires training to use and is employed by professional team trainers and physios, as well as specialized running coaches.

### Matching market needs

Nordic Semiconductors' nRF51 and nRF52 Series SoCs allow

manufacturers to choose configurable ANT and Bluetooth low energy SoftDevices (RF protocol software or 'stacks') to keep their protocol options open, enabling them to adapt to new developments in ANT+ and Bluetooth low energy profiles, and corresponding development by sportswatch,

smartphone, and bike computer manufacturers. In a new market such as running power, having the flexibility to adapt the wireless strategy without incurring any costly hardware redesign and minimizing firmware changes is a significant advantage.

Having this flexibility in a compact SoC format is even better. The algorithms required to compute advanced running metrics such as power are complex and need substantial processing power, which demands a rechargeable battery. A compact SoC integrating radio, processor, Flash and RAM leaves space for a lithium-ion (Li-ion) cell without adding bulk or weight.

While running power meters are a new product category and it is unknown how popular they will prove to be, the potential market is substantial. In the U.K., running is ranked as the second largest sport by participation numbers (following swimming, and followed by cycling) with an estimated ten million participants (out of a 62 million population) with around five million participants in competitive running events. In the US (population 326 million), 17 million runners participated in competitive events. And in China (population 1.5 billion), where running is a newer fascination, 2 million participants competed in events in 2014, a number which has been rising significantly over the past decade. ■



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## ULP Wireless Q now available on Apple iPad and iPhone, Android tablets, and Amazon Kindle

Nordic Semiconductor's ULP Wireless Q keeps you up to date on everything that's happening in the Bluetooth Smart, ANT+, and proprietary ultra low power wireless technology sector

The Apple iPad version of ULP Wireless Q ([tinyurl.com/WQipac](http://tinyurl.com/WQipac)) is now joined by iPhone, Android ([tinyurl.com/WQandroid](http://tinyurl.com/WQandroid)), and Amazon Kindle ([tinyurl.com/WQkindle](http://tinyurl.com/WQkindle)) versions.

The digital version of ULP Wireless Q is designed to make the most of tablet devices' large high-resolution displays, and includes all the interactivity you'd expect, including links back to relevant articles archived on the Nordic website, new product releases, analysts' information, blogs, videos, and much more.

**ULP Wireless Q digital – your essential quarterly guide to all that's happening in ultra low power wireless technology in a mobile device-friendly format**



# Birth of the secure 'all-in-one' personal smartcard

Maneul Labs claims its smartcard is one of the first 'all-in-one' payment solutions and can replace up to 200 other cards. ULP Wireless Q explains how Nordic's technology is playing a vital role in the product's success

If your wallet is the size of a house brick, chances are the culprit will be the volume of 'plastic' cards you feel obliged to carry to go about your daily life. Credit and debit cards, loyalty and membership cards, transportation, health care, insurance, store cards, the list goes on and on.

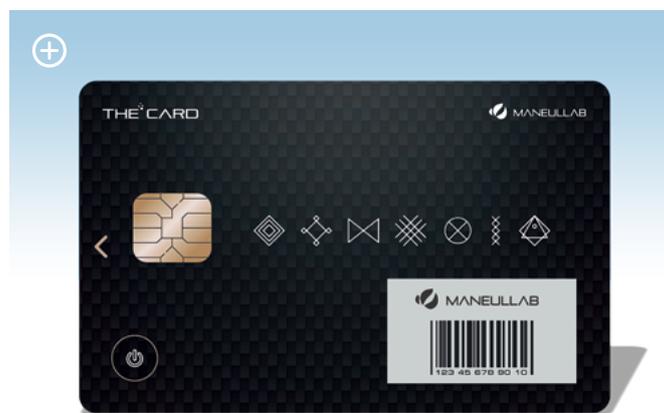
But this may be about to change if the vision of South Korean IT venture company, Maneul Lab, and its appropriately branded 'The Card' is widely adopted by financial, retail, and transport corporations - and in turn consumers.

The Card is an "all-in-one" smartcard solution that supports a range of payment methods including Bluetooth low energy, Near Field Communication (NFC), embedded IC, dynamic magnetic stripe, and barcode technologies, and can replace up to 200 existing payment, transport, and membership cards.

Sion Choi, Maneul Lab's Global Business Development Manager, is understandably a passionate advocate of smartcard technology, but acknowledges the market, if not the technology, is still in its relative infancy.

"The all-in-one smartcard market has not yet been fully pioneered," says Choi. "But what we expect is that if the technology is adopted by renowned institutions in financial, security, and transportation industries, then it will gain recognition with their customers, and that will drive an increasing rate of penetration."

To that end, Maneul Lab is currently under contract negotiations with a number of business entities across the U.S, Europe, and Asia. In most cases these companies are distributors who see the potential in reselling



**The Card has the potential to eliminate dozens of payment, membership, and transportation cards, with a single all-in-one smartcard solution**

the smartcard solution to local banks and card companies.

"We are undergoing distribution negotiation for quantities in excess of five million of The Card," says Choi. "If negotiations go well and it is adopted by financial institutions it will hopefully be confirmation of the card's suitability for purpose, and that should provide a bridge for us to direct sell to the consumer."

The information held on the user's other cards can be loaded onto the single all-in-one smartcard from a partner app on a Bluetooth 4.0 (or later) mobile, via a Nordic Semiconductor-powered Bluetooth low energy wireless link. Users can then select which card they want to use either by pushbutton, or scrolling through their stored cards in the Electronic Paper Display (EPD) panel on the smartcard, depending on which version of The Card they are using.

The smartcard supports a range of payment or cash withdrawal options including ATMs, online, and offline, NFC transportation, as well as mobile payments. Beyond standard PIN-based security, additional security

is provided by way of IC and NFC lock control. This allows the user to lock the embedded IC or NFC functionality from the app until the card is ready to use. Should further security be necessary, an optional one-time password feature can be enabled, requiring a secondary code to operate the smartcard.

## Essential ingredient

"Before the decision [on which chip to use was made], we always considered Bluetooth low energy wireless technology as our solution's essential component because of its merits and wide range of applications," explains Choi. "Our priority was a lightweight, small size, and power-friendly solution, and that's how we arrived at the Nordic System-on-Chip [SoC]."

"The nRF51822 was the most recently-introduced Bluetooth low energy chip on the market at the time we employed it. But on top of that, competitively, its size and package height was thinner and smaller than other manufacturers' chips. That was key to our selection of Nordic's nRF51822 SoC."

Equally, battery life was a critical consideration. The Card employs a 10-mAh Li-ion battery providing up to one month of battery life in standard operation, thanks in part to the ultra low power characteristics of the nRF51822 SoC. The battery can be recharged wirelessly by activating NFC on the user's smartphone, with a charge time of between one and two hours. In the event of low battery, users can view and select the card they wish to use via the app on their mobile. The rechargeable battery has an overall lifespan of two years before The Card requires replacement.

According to Choi, the nRF51822 SoC's large capacity 256kB/128kB Flash memory provides The Card with its most notable advantage over competitive smartcards. "The Nordic chip's Flash memory [capacity] allows The Card to hold up to 200 cards at once," says Choi. "The best known solution from another developer can hold only eight." Considering 16 is the average number of plastic cards that people in the U.S. carry, the additional storage is going to be welcome to many consumers.

"By integrating all their credit, membership, and transportation cards in the one card device, consumers won't have to surf around their wallet, or retain various complicated membership applications on their smartphone," says Choi. "Put simply, they can have a lighter wallet, or perhaps even no wallet at all." For those of us still carting around a leather brick in our back pocket, that can't come soon enough. ■

*For more information about Maneul Lab and 'The Card' go to [www.maneullab.com](http://www.maneullab.com).*

# RollerSafe Roller Skis

Allowing the user to replicate the experience of cross country skiing on tarmac, these roller skis employ wirelessly-operated hydraulic disc brakes to ensure a safe ride

The RollerSafe brakes are operated via a squeezable trigger remote that connects to the user's existing ski poles. When the trigger is squeezed, the wireless connection sends a signal to engage the disc brakes. The 1500mAh Li-ion battery has a charge time of seven hours and provides 50 hours of braking in normal usage between recharges.

According to market research company Technavio, the global market for sports equipment will reach \$83 billion by 2020, driven in large part by increased demand for technology. Unlike existing roller skis that either employ mechanical friction-based braking, or have no braking functionality at all, **RollerSafe** not only offers wireless-operated hydraulic braking, but also allows the user to adjust brake force from a smartphone app

RollerSafe makes the most of Nordic Semiconductor's nRF51822 SoC's multiprotocol capabilities. Mature, 2.4GHz proprietary connectivity provides low-latency wireless remote control of the roller skis' brakes while Bluetooth low energy technology is used to wirelessly connect RollerSafe to a Bluetooth 4.0 (or later) mobile to enable the adjustment of braking parameters via a smartphone app.

The first modern day roller skis were built in the mid-1930s in Italy as a way to train in the summer months. However, according to Roland Huntford in his book *Two Planks and a Passion*, the first pair of roller skis were actually used by Norsemen in the 1600s, who in the absence of snow would attach wheels to the underside of their skis to speed their progress across the ground.

Cross-country skiing has been contested at the Winter Olympic Games since the first Games in 1924, and Nordic countries have dominated the sport ever since. **Norway** leads the cumulative medal count with 107 medals, with Finland second on 76, and Sweden third with 74.



# What's trending on Nordic's social networks

Nordic's Facebook and Twitter presence is buzzing with discussion about ULP chips, #IoT, business trends, and more. ULP Wireless Q joins the followers

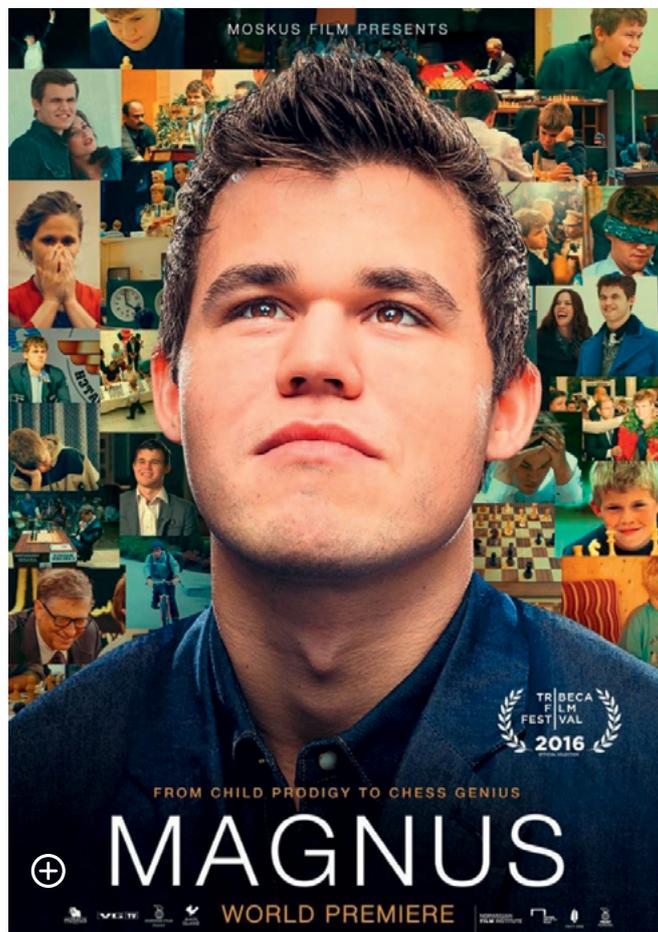
ULP Wireless Q's quarterly frequency allows the editorial team to report in detail and bring its readers a digest of the key developments in Bluetooth low energy, ANT, and 2.4 GHz proprietary technology. But the downside is there's so much happening at Nordic and in the industry between editions that we can't cover it all. But that doesn't mean you have to miss out; Nordic's Facebook and Twitter pages can give you a daily overview of where the company and the technology are heading. For those of you yet to follow Nordic's social media presence here's a snapshot of what's trending on Facebook and Twitter at the time this edition of ULP Wireless Q went to press.



## Magnus movie released

Top of Nordic's Facebook page was Magnus Carlsen, the Nordic-sponsored World Chess Champion ([see ULP WQ Autumn 2013 pg6](#)). The item discussed Carlsen as the subject of a new film entitled "MAGNUS". The film was described by review website The Hollywood News as "an engrossing, truly inspirational new documentary" that "focusses on the story of World Champion chess player Magnus Carlsen, an absolute genius who, in his early twenties, managed to achieve, and maintain, the highest rating in chess history". The film premiered at the Tribeca Film Festival in April, and is well worth seeing for chess and non-chess fans alike.

Next up is a Nordic-powered rocket. Using an nRF52 Series SoC, Tony Wu designed and



A documentary about Nordic-backed chess star Magnus Carlsen wowed the critics at the Tribeca Film Festival, reports Nordic's social media

built the rocket as a student project during his stay at Nordic's Trondheim HQ. Nordic Bluetooth low energy connectivity allowed Wu to launch the rocket from a safe distance using his smartphone and receive telemetry data about the rocket's performance while it remained in range. You can see a video of the rocket's maiden flight at this link (which also shows some of the nice features of Nordic's nRF Connect app): <https://www.facebook.com/nordicsemiconductor/videos/1543362209022887/>

[com/nordicsemiconductor/videos/1543362209022887/](https://www.facebook.com/nordicsemiconductor/videos/1543362209022887/)

The Facebook page also included news of another student project, this time a mini quadcopter that uses an nRF52 Series SoC for both flight control and radio communication. What's particularly notable about the quadcopter is that it demonstrates the power of the nRF52 Series SoC as a single-chip Bluetooth low energy solution. Many quadcopters require one chip

to control the quadcopter and keep it stable in the air, and a second to maintain wireless connectivity. The nRF52 SoC is capable of replacing both in turn simplifying the PCB design, reducing cost, and shrinking size. Check out the design in this video: <https://www.facebook.com/nordicsemiconductor/videos/1518123608213414/>

Nordic's Facebook page includes regular "Did You Know" items such as the fact that the company passed a significant milestone in September when the 500th employee joined the company. Just five years ago the company had only 161 employees. We also found out that people of 41 different nationalities work for the company.



## @NordicTweets

Meanwhile on @NordicTweets microprocessor IP vendor ARM (whose technology Nordic uses in its nRF51 and nRF52 Series SoCs) asked if sleep could be the next horizon for wearables. Nordic technology is being used to offer insight into the quantity and quality of sleep.

Nordic's Twitter feed also highlighted how, within a few years, we will see enterprise-grade Bluetooth infrastructure solutions along the lines of today's Wi-Fi WLANs by retweeting an opinion article by Peter Thornycroft, an engineer with Aruba, a Hewlett-Packard Enterprise company.

And finally, the feed included a Tweet from the ARMmbed blog including videos of how to code the BBC micro:bit, the Nordic nRF51822 SoC-powered pocket-sized computer that's being rolled out to around one million year 7 schoolchildren in the U.K. ([See ULP WQ Summer 2016 pg10.](#))

Here we've only been able to scratch the surface of the postings that occur daily on Nordic's social media. If you want much more, head over to <https://www.facebook.com/nordicsemiconductor> and <https://mobile.twitter.com/nordictweets> to see what's hot.

# PEOPLE & PLACES

Minhua “Kevin” Ai



## Aiming high in Shanghai helps keep Nordic’s Chinese customers happy

**H**i, I’m Minhua (in English I use “Kevin”) Ai and I recently joined Nordic as Field Application Engineer (FAE) working in the new Shanghai office.

As an FAE keeping the customer happy – be they a direct Nordic customer or a Nordic distributor’s customer – is at the center of everything I do. I get a great deal of pleasure listening to customers to learn what they need, working alongside them during development and testing, and ultimately seeing their end-product successfully to market.

This is extremely important in China because the sheer size of the market has made it a battlefield for ultra low power (ULP) wireless: every semiconductor company knows that to win in China is to win in the world.

I do not therefore take for granted that in China I am joining a long line of local Nordic FAEs who have helped get Nordic-based end products into the hands of hundreds of thousands of people, including my own friends or relatives, and in doing so help make Nordic a world-leader in ULP wireless.

To ensure I contribute fully I seek to continually improve through experience my professional skills, plus



**Kevin enjoys travelling and the experience of discovering new places, cultures, foods, and things**

my technical knowledge of ULP wireless and the unique differentiators of Nordic’s technologies. Although I have not been at Nordic long, I already feel supported by my colleagues every step of the way.

A recent example was when I was working with a customer that had selected a Nordic nRF52832 SoC for a medical application. The schedule was a super-tight three-to-four months to market, the application involved developing an iOS and Android app from scratch, and the customer had only one development engineer.

I won’t forget the hours and days I spent with that engineer trouble-shooting each support

request or question along the way, culminating in a stubborn Bluetooth low energy over-the-air device-firmware-update (OTA DFU) problem that although not caused by a Nordic-part of the

design, we took responsibility to solve so the customer could get their end-product complete. I learnt a huge amount too. Outside of work one of the things I most enjoy is travelling with my wife. We try to take two long vacations a year to do this, plus dozens of short weekend trips away when we get the opportunity. We both find the experience of discovery very relaxing and spiritually fulfilling.

I, like many Chinese people, also practice Tai Chi – the traditional Chinese exercise. Regardless of age or gender, Tai Chi helps keep your mind and body healthy by balancing the flow of vital energy (called ‘Qi’ and pronounced “chi” hence the English spelling of Tai Chi) around the body.

When I’m not practicing Tai Chi (which I usually do in the mornings) I enjoy walking to relax after work: usually by taking a half-hour stroll most days after supper with my wife.

Food is also a big part of our lives, so at weekends when we have more time we will often drive as far as 20 kilometers to the suburbs of Shanghai to source fresh, original ingredients, and really savor preparing lovely meals together.

When I sit down to enjoy the delicious food made by ourselves, life feels really good. ■

### Personal Profile

NAME:  
**Minhua “Kevin” Ai**

JOB TITLE:  
**Field Application Engineer**

JOINED NORDIC:  
**February 2016**

BASED:  
**Shanghai, China**

INTERESTS INCLUDE:  
**Traveling, Tai Chi, walking, cooking**

*“The sheer size of the market in China has made it a battlefield for ultra low power wireless: every semiconductor company knows that to win in China is to win in the world”*



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